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Assistant Commissioner for Patents
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Washington, D.C. 20231

Sir:

Transmitted herewith for filing is the patent application of

Inventor(s): ITO, Kenji

For: DIGITAL CAMERA AND METHOD OF CONTROLLING OPERATION OF SAME

Enclosed are:

- ☒ X A specification consisting of 20 pages
- ☒ X 6 sheet(s) of formal drawings
- ☒ X An assignment of the invention
- ☒ X Certified copy of Priority Document(s)
- ☒ X Executed Declaration X Original Photocopy
- A verified statement to establish small entity status under 37 CFR 1.9 and 37 CFR 1.27
- Preliminary Amendment
- Information Disclosure Statement, PTO-1449 and reference(s)

Other _____

The filing fee has been calculated as shown below:

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FOR	NO. FILED	NO. EXTRA	RATE	FEE
BASIC FEE	***** ***** *****	***** ***** *****	***** ***** *****	\$690.00
TOTAL CLAIMS	5 - 20 =	0	x18 = \$	0.00
INDEPENDENT	2 - 3 =	0	x78 = \$	0.00
MULTIPLE DEPENDENT CLAIM PRESENTED <u>no</u>			+260 = \$	0.00
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Respectfully submitted,

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SPECIFICATION

TITLE OF THE INVENTION

DIGITAL CAMERA AND METHOD OF CONTROLLING OPERATION OF
SAME

5 BACKGROUND OF THE INVENTION

Field of the Invention

This invention relates to a digital camera capable of electronic zoom processing, and to a method of controlling the operation of the camera.

10 Description of the Related Art

In a portable image pick-up apparatus such as a digital camera, a subject is imaged by a solid-state electronic image sensing device such as a CCD. An image having a high resolution is obtained by providing the
15 solid-state electronic image sensing device with a large number of pixels.

Some digital cameras are provided with a display device, and shooting angle is decided while the image of the subject is displayed on the display device. The
20 resolution of the display device provided on the digital camera is not high and is in general lower than that of the solid-state electronic image sensing device.

In order to image a subject at a fixed period of 1/60 of a second using a solid-state electronic image
25 sensing device and display the image of the subject, which is represented by a video signal obtained by such imaging, smoothly in the form of a movie on a display device provided on a digital camera, it is required that

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the number of lines in the vertical direction of the image represented by the video signal output from the solid-state electronic image sensing device approximate the number of lines of the display device. In order to
5 achieve this, the device is driven in such a manner that signal charge, which has accumulated in the photoelectric transducers constituting the solid-state electronic image sensing device, will be read out at intervals of a plurality of lines, by way of example.
10 This is referred to as "pixel downsampling".

Digital cameras capable of electronic zooming also have come into widespread use. By applying a zoom command, the image of a subject within a prescribed area is enlarged by interpolating pixels.

15 When pixels are downsampled in order to display a moving image on the display device, resolution declines. If such an image is subjected to electronic zoom processing, often the image undergoes a further decline in resolution.

20 SUMMARY OF THE INVENTION

Accordingly, an object of the present invention is to arrange it so that there is no decline in resolution even if electronic zoom processing is executed.

According to the present invention, the foregoing
25 object is attained by providing a digital camera comprising: an imaging unit for imaging a subject at a fixed period by a solid-state electronic image sensing device and outputting a video signal, which represents

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The present invention provides also an operation control method suited to the camera described above. Specifically, the present invention provides a method of controlling a digital camera having an imaging unit for imaging a subject at a fixed period by a solid-state electronic image sensing device and outputting a video signal, which represents the image of the subject obtained by imaging, upon downsampling the video signal at a given downsampling ratio, the method comprising the steps of: applying an electronic zoom command and a

The present invention provides also an operation control method suited to the camera described above. Specifically, the present invention provides a method of controlling a digital camera having an imaging unit for imaging a subject at a fixed period by a solid-state electronic image sensing device and outputting a video signal, which represents the image of the subject obtained by imaging, upon downsampling the video signal at a given downsampling ratio, the method comprising the steps of: applying an electronic zoom command and a

zoom magnification; subjecting the video signal output from the imaging unit to electronic zoom processing in accordance with the applied zoom magnification in such a manner that an image represented by the video signal
5 output from the imaging unit will be enlarged; displaying the image represented by the video signal, which has been subjected to the electronic zoom processing, on the display device; and reducing the downsampling ratio in response to application of the
10 electronic zoom command.

In accordance with the present invention, a subject is imaged at fixed periods by the imaging unit. The latter is capable of outputting the image of the subject, which has been obtained by imaging, upon
15 downsampling the image at a given downsampling ratio. The image of the subject is displayed on the display device by applying the video signal, which is output from the imaging unit, to the display device. Since the pixels constituting the image of the subject rather than
20 the image capable of being read by the imaging unit are downsampled at a given downsampling ratio, a smooth moving image can be displayed on the display device. The downsampling may be performed by a downsampling circuit.

25 When the electronic zoom command is applied, electronic zoom processing is carried out in accordance with the electronic zoom command. The enlarged image of the subject is displayed by applying the electronic zoom

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processed video signal to the display unit.

When the electronic zoom command is applied, the downsampling ratio is reduced. Accordingly, the resolution of the image represented by the video signal output from the imaging unit rises in comparison with the resolution that prevailed prior to the reduction in the downsampling ratio. Thus an image having a high resolution can be obtained even when electronic zoom processing is applied.

10 By way of example, the downsampling ratio is reduced by making the number of lines of the image represented by a video signal that has undergone zoom processing greater than the number of lines of the image represented by the video signal output from the imaging unit.

When the video signal is output in sync with an applied synchronizing signal, it is advisable to reduce the downsampling ratio in sync with this synchronizing signal.

20 By reducing the downsampling ratio, it is possible to prevent disturbance of the image of the subject represented by the video signal output from the imaging unit.

The camera may be provided with a mode setting unit for setting an image-quality priority mode. In this case control is exercised in such a manner that the downsampling ratio is reduced when the image-quality priority mode has been selected by the mode selecting

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unit.

Thus, the user can set whether to give priority to image quality or to a display of a smoothly moving image.

5 Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures
10 thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a block diagram illustrating the electrical construction of a digital still camera according to a preferred embodiment of the present
15 invention;

Fig. 2 illustrates the imaging area of a CCD;

Fig. 3 illustrates the relationship among the image of subject obtained by 1/4-downsampling drive, a zoom area and a display area;

20 Fig. 4 illustrates the relationship among the image of subject obtained by 1/2-downsampling drive, a zoom area and a display area;

Figs. 5a to 5c illustrate a plurality of schemes for driving a CCD and some of the pixels of an image
25 represented by a video signal obtained by these drive schemes;

Fig. 6 illustrates the relationship between 1/4-downsampling drive and interpolated pixels;

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Fig. 7 illustrates the relationship between 1/2-downsampling drive and interpolated pixels; and

Fig. 8 is a time chart illustrating the operation of the digital still camera.

5 DESCRIPTION OF THE PREFERRED EMBODIMENT

A preferred embodiment of the present invention will now be described with reference to the drawings.

Fig. 1 is a block diagram illustrating the
10 electrical construction of a digital still camera according to a preferred embodiment of the present invention.

The digital still camera has its operation controlled by a CPU 20.

15 The digital still camera has an electronic zoom function. An output signal from a zoom switch 13, which is for applying an electronic zoom command and enlargement ratio (zoom magnification) and for designating a zoom area in which enlargement is to be
20 performed, is input to the CPU 20.

The digital still camera can be set selectively to an image-quality priority mode and a motion priority mode by a mode switch 14. A signal indicating the mode setting is input from the mode switch 14 to the CPU 20.
25 The image-quality priority mode is for raising image resolution by changing the driving scheme of a CCD 2, described later, when the electronic-zoom enlargement ratio exceeds a predetermined enlargement ratio. The

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motion priority mode gives priority to motion of an image (so as to smoothen the motion of the image), which is displayed on a display device 8, by fixing the driving scheme of the CCD 2.

5 The digital still camera is further provided with a shutter-release button 15. A signal indicating depression of the shutter-release button 15 also is input to the CPU 20.

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10 A zoom motor 11 is controlled by the CPU 20. A zoom lens 1 is positioned by the zoom motor 11 in such a manner that the image of a subject is enlarged at an enlargement ratio supplied from the zoom switch 13. A light image representing the image of the subject is formed on the photoreceptor surface of the CCD 2 by the
15 zoom lens 1.

 The CCD 2 is controlled by an imaging synchronization signal VI and other control signals output from a timing generator (TG) 12. The CCD 2 images a subject at a fixed period (1/60 of a second) in
20 sync with the imaging synchronization signal VI and outputs a video signal. The video signal output from the CCD 2 is input to an analog/digital conversion circuit 4 via a CDS (correlated double sampling circuit)
3. The analog/digital conversion circuit 4 converts the
25 analog video signal to digital image data, which is input to a signal processing circuit 5.

 The digital image data undergoes processing such as a gamma correction and a white balance adjustment in the

signal processing circuit 5. The latter includes also a function for executing electronic zoom processing (pixel interpolation processing). Image data output from the signal processing circuit 5 enters an encoder 6, which
5 subjects the image data to prescribed encoding processing. The encoder 6 is provided with a reproduction synchronization signal VD from the CPU 20 and outputs the image data in sync with the reproduction synchronization signal VD.

10 The digital image data is converted to an analog video signal by a digital/analog conversion circuit 7. The analog video signal resulting from the conversion is applied to the display device 8, whereby the image of the subject is displayed in the form of a movie at the
15 fixed period.

If the shutter-release button 15 is pressed, the image data output from the signal processing circuit 5 is input to a memory-card controller 9. The latter records the image data on a memory card 10.

20 Fig. 2 shows the imaging area of the CCD 2, and Figs. 3 and 4 show the image of a subject, which is represented by a video signal output from the CCD 2 when the CCD 2 is driven for downsampling, and the image of the subject (display image) displayed on the display
25 device 8. Figs. 5a to 5c show some pixels of the image represented by the video signal output from the CCD 2.

The CCD 2 has 1280 pixels horizontally and 960 pixels vertically. If the shutter-release button 15 is

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pressed, a video signal composed of 1280 pixels horizontally and 960 pixels vertically is output from the CCD 2 (see Fig. 5a) and converted to digital image data, which is recorded on the memory card 10.

5 The display device 8 is capable of displaying an image composed of 640 pixels horizontally and 480 pixels vertically.

When a movie image is displayed on the display device 8 in the manner described above, the CCD 2 is
10 controlled by the timing generator 12 in such a manner that the number of pixels in the vertical direction will be reduced to one-fourth (this is referred to as "1/4-downsampling drive"). Since the number of pixels vertically of the image represented by the video signal
15 output from the CCD 2 becomes one-fourth the number of pixels of the imaging area of CCD 2, read-out can be performed at high speed. Thus the movie image is displayed on the display device 8 smoothly. The image represented by the video signal output from the CCD 2
20 thus has 1280 pixels horizontally and 240 pixels vertically (see Figs. 3 and 5c, in which the dashed lines in Fig. 5c indicate the downsampled pixels).

A zoom area is designated by the zoom switch 13 in the image represented by these 1280 pixels in the
25 horizontal direction and 240 pixels in the vertical direction. The signal processing circuit 5 executes electronic zoom processing in such a manner that the image in the designated zoom area is displayed in the

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When 1/4-downsampling drive is performed, the CCD 2 outputs the video signal at a rate of one pixel per four pixels of the pixels constituting the imaging area of

the CCD 2 in the vertical direction thereof. More specifically, the CCD 2 outputs a video signal in which the pixels have been downsampled at a rate of three pixels out of four. In Fig. 6, the pixels that have
5 been downsampled are represented by the dashed lines and pixels that have not been downsampled are represented by the solid lines.

The enlargement ratio $2\times$ causes an area which is half the imaging area of the CCD 2 in the vertical
10 direction to be displayed in the display area of the display device 8. When $1/4$ -downsampling drive is performed, the number of pixels vertically of the video signal output from the CCD 2 is 240. Half this number of pixels is 120. This video signal having 120 pixels
15 in the vertical direction is interpolated to a video signal having 480 pixels in the vertical direction. In $1/4$ -downsampling drive, therefore, the enlargement ratio $2\times$ multiplies one pixel by a factor of four in the vertical direction (this is four-fold interpolation).
20 In Fig. 6, the hatched pixels indicate pixels that have been interpolated.

Fig. 7 illustrates some of the pixels of an image represented by a video signal obtained by $1/2$ -downsampling drive and pixels in a case where an
25 enlargement ratio of $2\times$ has been applied.

When $1/2$ -downsampling drive is performed, the CCD 2 outputs the video signal at a rate of one pixel per two pixels of the pixels constituting the imaging area of

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the CCD 2 in the vertical direction thereof. More specifically, the CCD 2 outputs a video signal in which the pixels have been downsampled at a rate of one pixel out of two. In Fig. 7, the pixels that have been
5 downsampled are represented by the dashed lines and pixels that have not been downsampled are represented by the solid lines in a manner similar to that of Fig. 6.

When 1/2-downsampling drive is performed, the number of pixels vertically of the video signal output
10 from the CCD 2 is 480. Half this number of pixels is 240. Interpolating this video signal having 240 pixels vertically to a video signal having 480 pixels vertically is equivalent to doubling the enlargement ratio. In 1/2-downsampling drive, the enlargement ratio
15 $2\times$ multiplies one pixel by a factor of two in the vertical direction (this is two-fold interpolation).

In 1/2-downsampling drive, two-fold interpolation is performed when the enlargement ratio is set to $2\times$ by the zoom switch 13. In Fig. 7, the hatched pixels
20 indicate pixels that have been interpolated.

Thus, even with the same enlargement ratio of $2\times$, the resolution of an image obtained based upon a video signal acquired by 1/2-downsampling drive is higher than the resolution of an image obtained based upon a video
25 signal acquired by 1/4-downsampling drive. The digital still camera according to this embodiment controls the CCD 2 by 1/4-downsampling drive up to an enlargement ratio of $2\times$ and by 1/2-downsampling drive when the

enlargement ratio surpasses $2\times$. As a result, a movie image having a comparatively high resolution is displayed on the display device 8.

Fig. 8 is a time chart when prevails when a subject is imaged by the digital still camera. This time chart is for a case where the image-quality priority mode has been set by the mode switch 14. It goes without saying that when the motion priority mode has been set by the mode switch 14, the switching between $1/4$ -downsampling drive and $1/2$ -downsampling drive is not carried out, as will be described next.

When the enlargement ratio that has been set by the zoom switch 13 is less than $2\times$, the CCD 2 is controlled by the timing generator 12 in such a manner that $1/4$ -downsampling drive is established. The CCD 2 outputs the video signal in sync with the imaging synchronization signal VI. The video signal is converted to digital image data that is then input to the encoder 6 via the signal processing circuit 5 in the manner described earlier.

The encoder 6 outputs the reproduced image data in sync with the reproduction synchronization signal VD (= $1/60$ of a second). The reproduced image data is converted to an analog video signal in the digital/analog conversion circuit 7, which inputs this signal to the display device 8.

Thus the video signal from the CCD 2 is output at a rate of once per two VD signal pulses and the movie

image is changed over at a rate of once per two VD signal pulses.

If the enlargement ratio is made $2\times$ by the zoom switch 13 at time t, the CCD 2 is controlled by the timing generator 12 in such a manner that 1/2-downsampling drive is established. The CCD 2 outputs the video signal in sync with the imaging synchronization signal VI in a manner similar to that when 1/4-downsampling drive is applied. The video signal is converted to digital image data that is input to the encoder 6 via the signal processing circuit 5.

The reproduced image data is output from the encoder 6 is sync with the reproduction synchronization signal VD and is converted to an analog video signal.

15 The latter is applied to the display device 8.

Thus the video signal from the CCD 2 is output at a rate of once per four VD signal pulses and the movie image is changed over at a rate of once per four VD signal pulses.

20 Thus, even when an image is displayed by an
electronic zoom function, a movie image having a
comparatively high resolution can be obtained.

In the embodiment described above, changeover between 1/2-downsampling drive and 1/4-downsampling drive is performed in response to the enlargement ratio becoming 2x. However, it goes without saying that drive may be changed over by designating a different enlargement ratio.

As many apparently widely different embodiments of the present invention can be made without departing from the spirit and scope thereof, it is to be understood that the invention is not limited to the specific
5 embodiments thereof except as defined in the appended claims.

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WHAT IS CLAIMED IS:

1. A digital camera comprising:

an imaging unit for imaging a subject at a fixed period by a solid-state electronic image sensing device and outputting a video signal, which represents the image of the subject obtained by imaging, upon downsampling the video signal at a given downsampling ratio;

an electronic-zoom command unit for applying an electronic zoom command and a zoom magnification;

a zoom unit for subjecting the video signal output from said imaging unit to electronic zoom processing in accordance with the zoom magnification, which has been applied from said electronic-zoom command unit, in such a manner that an image represented by the video signal output from said imaging unit will be enlarged;

a display control unit for performing control in such a manner that the image represented by the video signal output from said imaging unit will be displayed on said display device; and

a downsampling-ratio control unit for reducing the downsampling ratio in response to application of the electronic zoom command from said electronic-zoom command unit.

2. The camera according to claim 1, wherein said downsampling-ratio control unit reduces the downsampling ratio by making number of lines of an image represented by a video signal that has undergone zoom processing by

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said zoom unit greater than number of lines of an image represented by a video signal output from said imaging unit.

3. The camera according to claim 1, wherein said
5 imaging unit outputs a video signal in sync with a
synchronization signal applied thereto; and

said downsampling-ratio control unit reduces the downsampling ratio in sync with the synchronization signal.

10 4. The camera according to claim 1, wherein the camera
is provided with a mode setting unit for setting an
image-quality priority mode;

said downsampling-ratio control unit reducing the
downsampling ratio when the image-quality priority mode
15 has been set by said mode setting unit.

5. A digital camera having an imaging unit for imaging a subject at a fixed period by a solid-state electronic image sensing device and outputting a video signal, which represents the image of the subject obtained by imaging, upon downsampling the video signal at a given downsampling ratio, said method comprising the steps of:

applying an electronic zoom command and a zoom magnification;

subjecting the video signal output from the imaging
25 unit to electronic zoom processing in accordance with
the applied zoom magnification in such a manner that an
image represented by the video signal output from the
imaging unit will be enlarged;

displaying the image represented by the video signal, which has been subjected to the electronic zoom processing, on the display device; and

reducing the downsampling ratio in response to
5 application of the electronic zoom command.

ABSTRACT OF THE DISCLOSURE

A CCD is driven so as to output a video signal at a rate of one line out of four up to an enlargement ratio of 2x. If the enlargement ratio of 2x is surpassed, the
5 CCD is controlled so as to output a video signal at a rate of one line out of two. Since resolution of the image represented by the video signal output from the CCD is raised, an image having a comparatively high resolution is obtained even when the image is enlarged
10 by an electronic zoom function.

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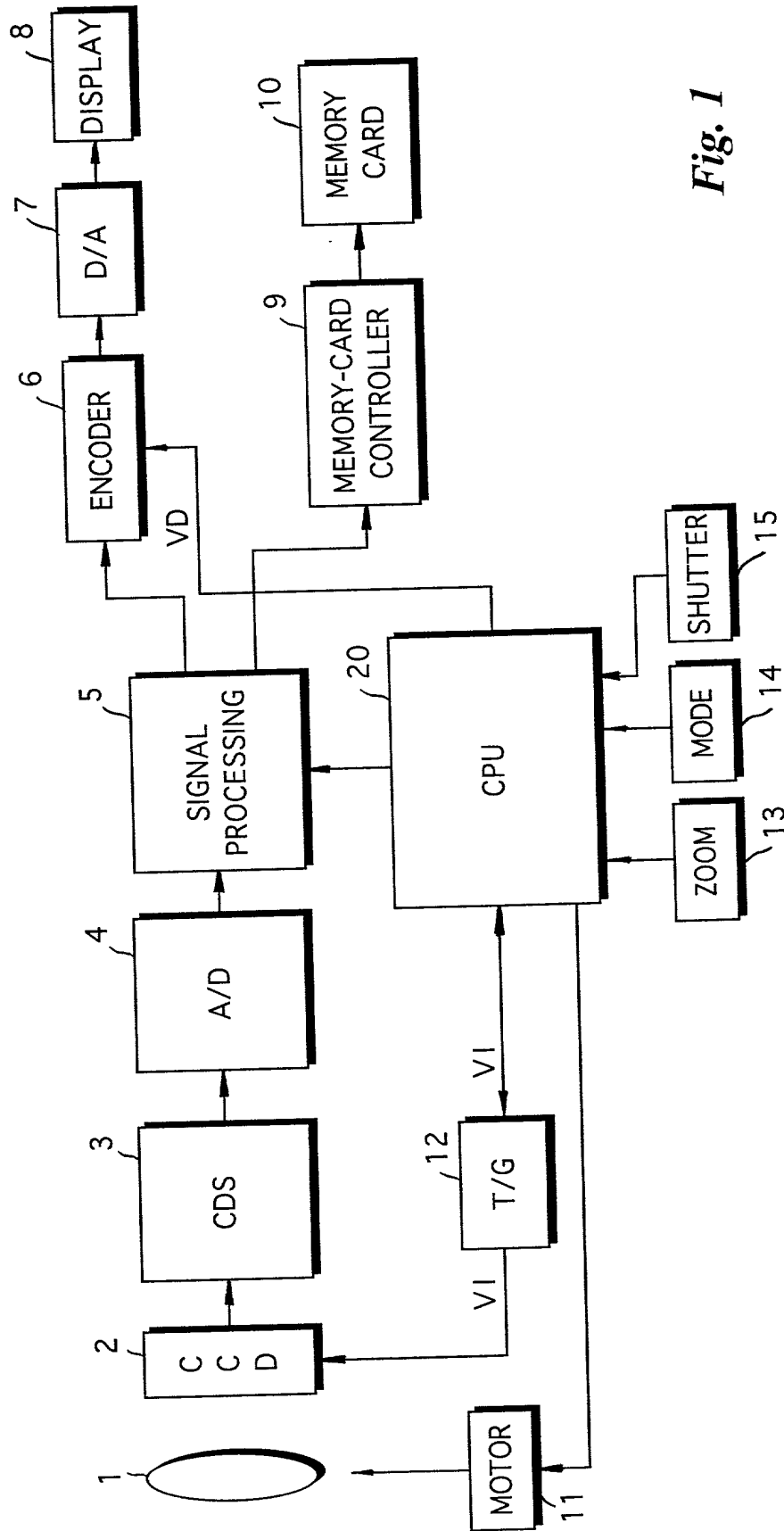
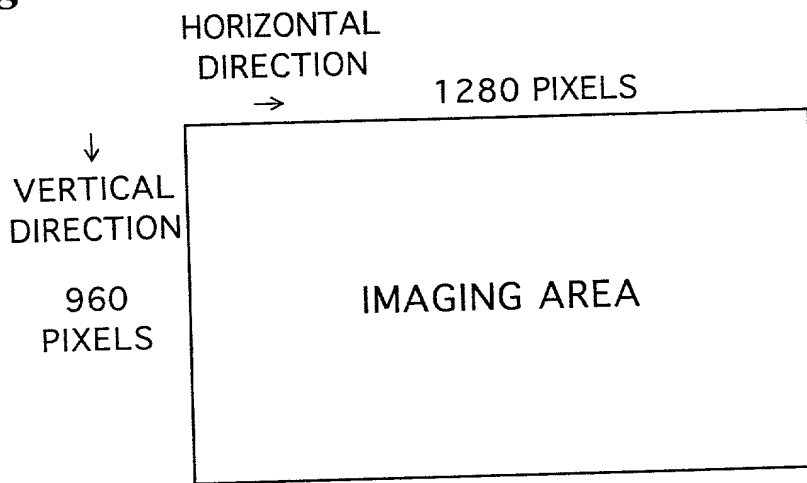
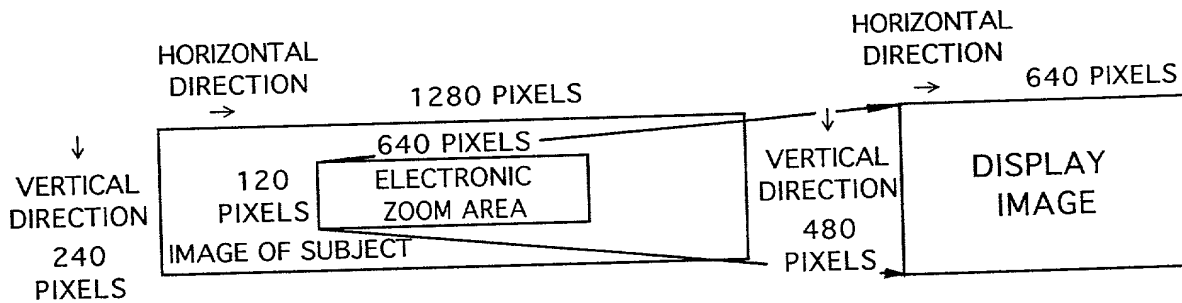


Fig. 1

Fig. 2**Fig. 3**

AT 1/4-DOWNSAMPLING DRIVE

**Fig. 4**

AT 1/2-DOWNSAMPLING DRIVE

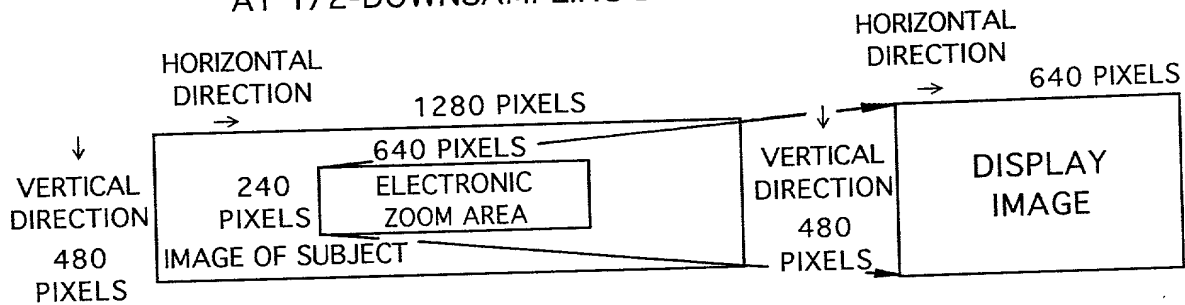


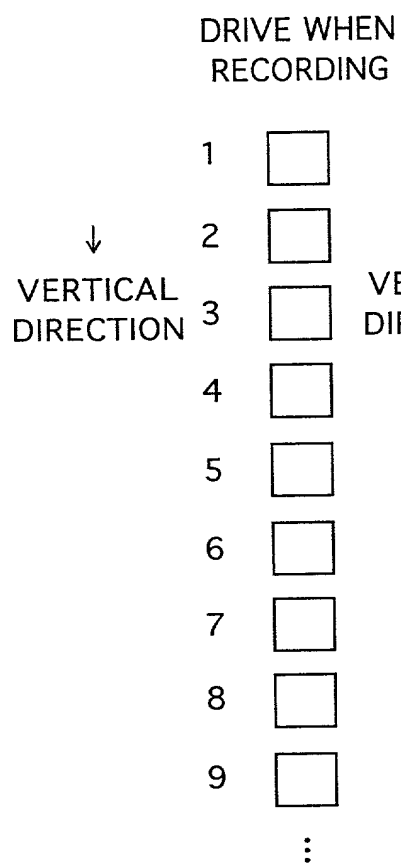
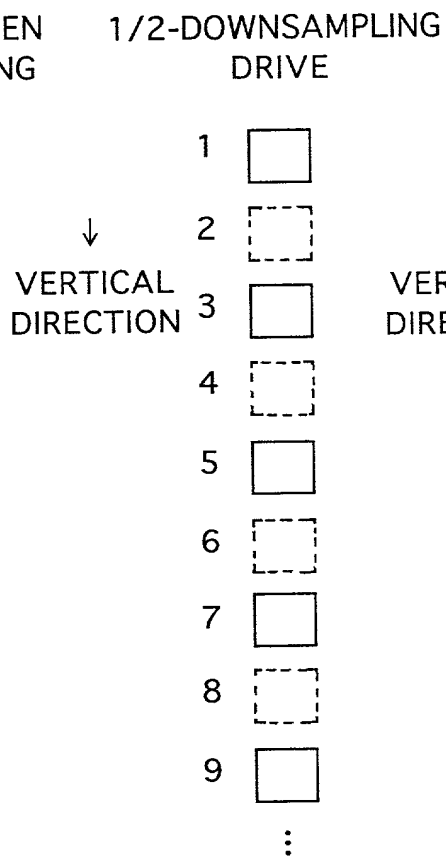
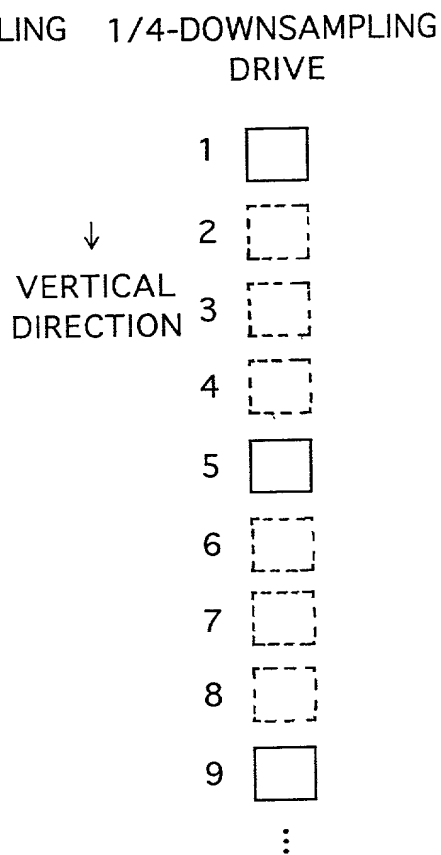
Fig. 5a**Fig. 5b****Fig. 5c**

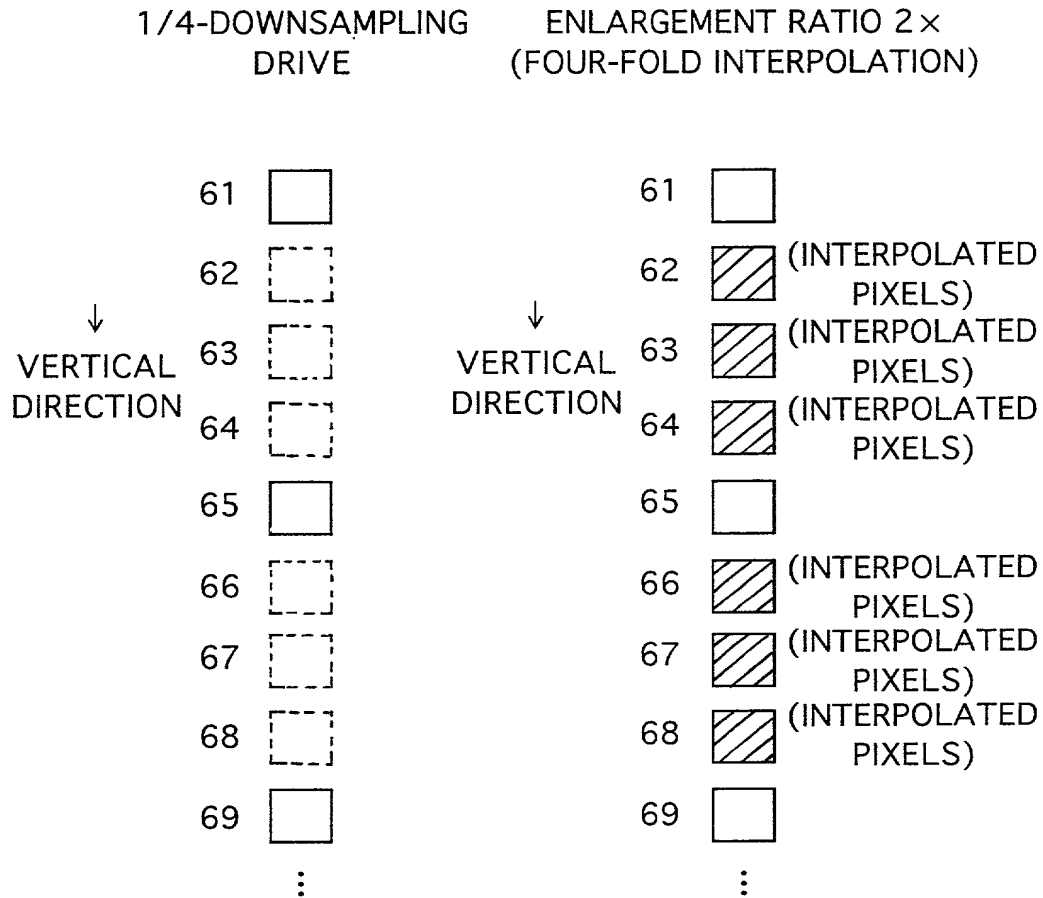
Fig. 6

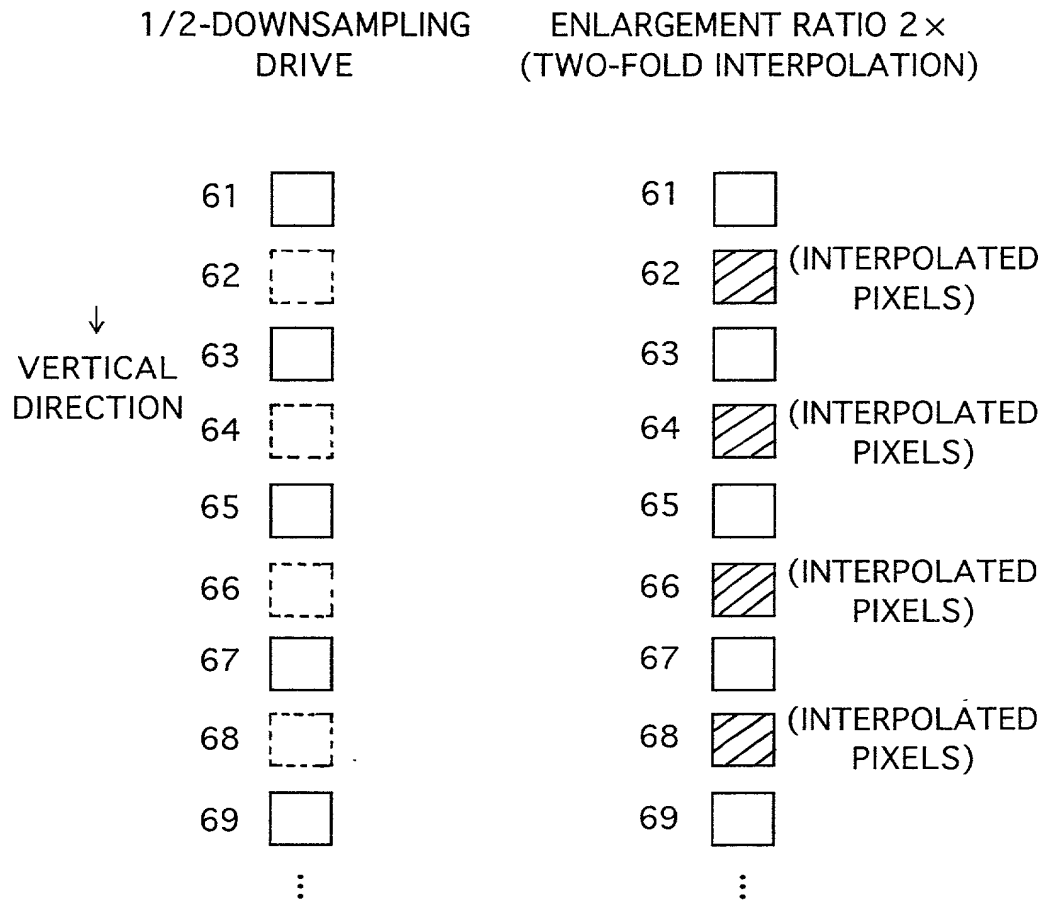
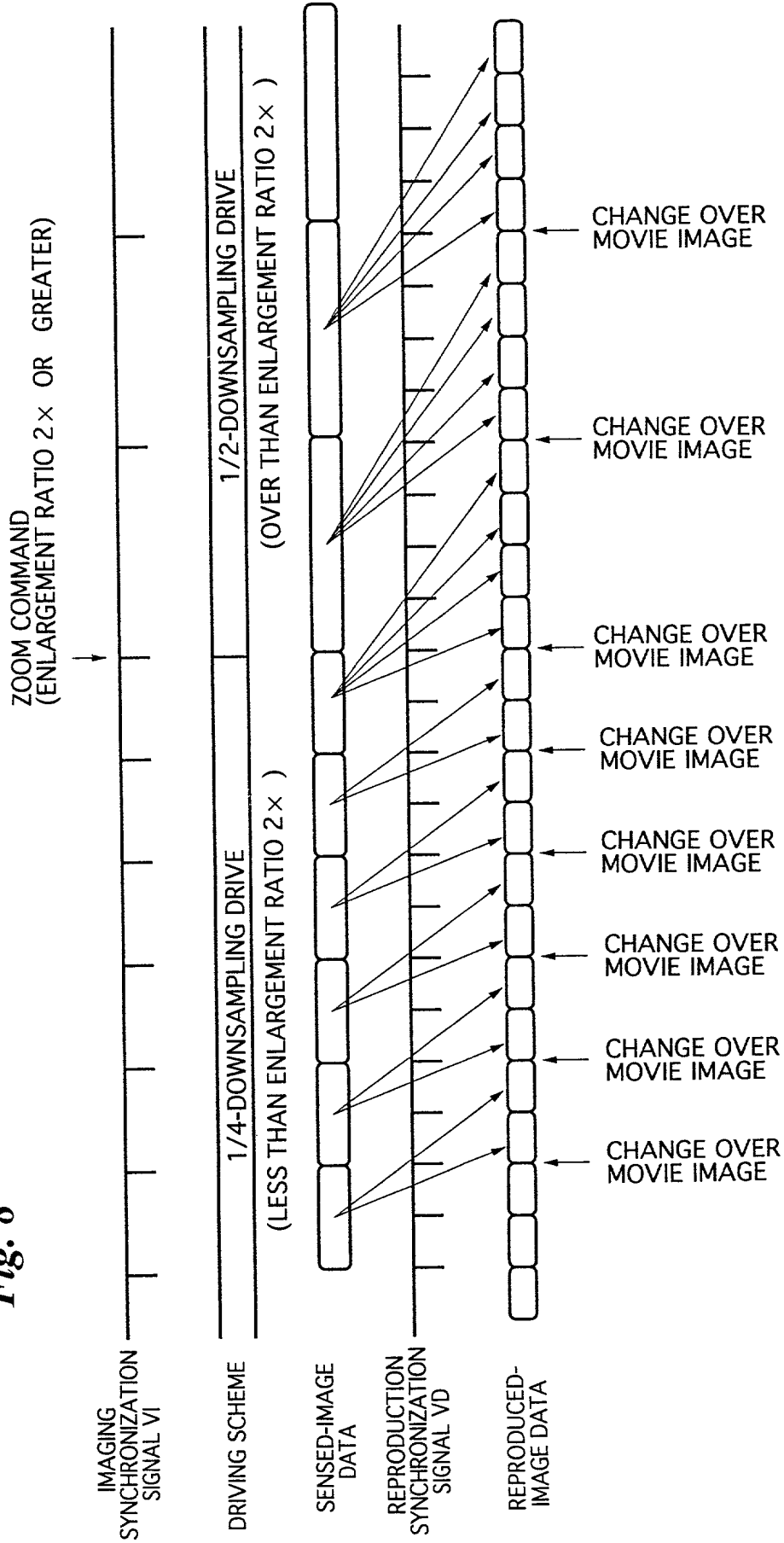
Fig. 7

Fig. 8



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0905-0243P

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COMBINED DECLARATION AND POWER OF ATTORNEY
FOR PATENT AND DESIGN APPLICATIONS

As a below named inventor, I hereby declare that: my residence, post office address and citizenship are as stated next to my name; that I verily believe that I am the original, first and sole inventor (if only one inventor is named below) or an original, first and joint inventor (if plural inventors are named below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

DIGITAL CAMERA AND METHOD OF CONTROLLING OPERATION OF SAME

Insert Title:

Fill in Appropriate
Information -
For Use Without
Specification
Attached:

the specification of which is attached hereto. If not attached hereto,
the specification was filed on _____ as
United States Application Number _____;
and amended on _____ (if applicable) and/or
the specification was filed on _____ as PCT
International Application Number _____;
amended under PCT Article 19 on _____ (if applicable)

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, §1.56.

I do not know and do not believe the same was ever known or used in the United States of America before my or our invention thereof, or patented or described in any printed publication in any country before my or our invention thereof or more than one year prior to this application, that the same was not in public use or on sale in the United States of America more than one year prior to this application, that the invention has not been patented or made the subject of an inventor's certificate issued before the date of this application in any country foreign to the United States of America on an application filed by me or my legal representative or assigns more than twelve months (six months for designs) prior to this application, and that no application for patent or inventor's certificate on this invention has been filed in any country foreign to the United States of America prior to this application by me or my legal representatives or assigns, except as follows.

I hereby claim foreign priority benefits under Title 35, United States Code, §119(a)-(d) of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)

Priority Claimed

Insert Priority
Information:
(if appropriate)

JP11-216059	Japan	07/30/1999	<input checked="" type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Month/Day/Year Filed)	Yes	No
_____	_____	_____	<input type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Month/Day/Year Filed)	Yes	No
_____	_____	_____	<input type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Month/Day/Year Filed)	Yes	No
_____	_____	_____	<input type="checkbox"/>	<input type="checkbox"/>
(Number)	(Country)	(Month/Day/Year Filed)	Yes	No

I hereby claim the benefit under Title 35, United States Code, §119(e) of any United States provisional applications(s) listed below.

Insert Provisional
Application(s):
(if any)

_____	_____
(Application Number)	(Filing Date)
_____	_____
(Application Number)	(Filing Date)

All Foreign Applications, if any, for any Patent or Inventor's Certificate Filed More than 12 Months (6 Months for Designs) Prior to the Filing Date of This Application:

Country	Application Number	Date of Filing (Month/Day/Year)
_____	_____	_____
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Insert Requested
Information:
(if appropriate)

I hereby claim the benefit under Title 35, United States Code, §120 of any United States and/or PCT application(s) listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States and/or PCT application in the manner provided by the first paragraph of Title 35, United States Code, §112, I acknowledge the duty to disclose information which is material to the patentability as defined in Title 37, Code of Federal Regulations, §1.56 which became available between the filing date of the prior application and the national or PCT international filing date of this application.

Insert Prior U.S.
Application(s):
(if any)

_____	_____	_____
(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)
_____	_____	_____
(Application Number)	(Filing Date)	(Status - patented, pending, abandoned)

I hereby appoint the following attorneys to prosecute this application and/or an international application based on this application and to transact all business in the Patent and Trademark Office connected therewith and in connection with the resulting patent based on instructions received from the entity who first sent the application papers to the attorneys identified below, unless the inventor(s) or assignee provides said attorneys with a written notice to the contrary:

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YOU MUST
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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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